U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-288 399

An Evaluation of Restorative Maintenance on Exhaust Emissions from 1975/1976 In-Use Automobiles in California

(U.S.) Environmental Protection Agency, Ann Arbor, MI

Oct 78

PB 288399

78-4

An Evaluation of Restorative Maintenance on Exhaust Emissions from 1975/1976 In-Use Automobiles in California

October, 1978

by

Patrick Farrell

Technology Assessment and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
U.S. Environmental Protection Agency

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

BIBLIOGRAPHIC DATA SHEET	1. Report No. 78-4	2.	PB288399

4. Title and Subtitle

An Evaluation of Restorative Maintenance on Exhaust Emissions from 1975/1976 In-Use Automobiles in California

5. Report Date: October, 1978

6.

7. Author(s): Patrick Farrell

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Technology Assessment and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address

U.S. Environmental Protection Agency
2565 Plymouth Rd.
Ann Arbor, Michigan 48105

13. Type of Report & Period Covered: technical

14.

15. Supplementary Notes

Reproduced from best available copy.

16. Abstracts

This paper describes the results of emissions testing on one hundred 1975-76 Model Year vehicles in California conducted by the U.S. EPA from March 1977 to Jan. 1978. The vehicles were moderate-mileage models of three major domestic manufacturers. Each was obtained randomly from private individuals and was subject to a series of tests before and after various stages of tune-up. The findings confirm the poor initial pass-rate of in-use vehicles and the ultimate ability of most vehicles to meet their applicable standards once maladjustments and disablements have been corrected. In comparing these results with those of 49 state vehicles in an identical program, the California vehicles exhibited lower absolute emission levels but were quite similar when displayed in relation to their more stringent standards.

17. Key Words and Document Analysis. 17a. Descriptors

Exhaust emissions

Fuel economy

17b. Identifiers/Open-Ended Terms

Air pollution

17c. COSATI Field Group

18. Availability Statement

Unlimited

19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 24
20. Security Class (This Page) UNCLASSIFIED	22. Price A02-A01

ABSTRACT

This paper describes the results of emissions testing on one hundred 1975-1976 Model Year vehicles in California conducted by the U.S. Environmental Protection Agency from March 1977 to January 1978. The vehicles were moderate-mileage models of the three major domestic manufacturers. Each was obtained randomly from private individuals. Each vehicle was subject to a series of tests before and after various stages of tune-up. The findings confirm the poor initial pass-rate of in-use vehicles and the ultimate ability of most vehicles to meet their applicable standards once maladjustments and disablements have been corrected. In comparing these results with those of 49-state vehicles in an identical program, the California vehicles exhibited lower absolute emission levels but were quite similar when displayed in relation to their more stringent standards.

Exhaust emissions testing of in-use vehicles has been conducted by the U.S. Environmental Protection Agency for the past several years. These studies, known as the Emission Factors Programs, were intended to compile data regarding emissions of in-use vehicles for use in calculations of air quality and overall effectiveness of current emission controls. Results of these programs have revealed that a substantial number of relatively new vehicles fail to meet the emissions standards for which their prototypes were certified, as evidenced in Table 1 (References 1, 2, and 3). The discrepancy between as-certified emissions and as-tested emissions on the in-use vehicles led to the development of the Restorative Maintenance Program. The basic purposes of the Restorative Maintenance program were:

1. To go beyond the basic emission factor testing in determination of apparent reasons for poor emission performance of in-use vehicles, and

2. To investigate and quantify the individual and combined effects of defects, disablement and maladjustment actions on exhaust emissions and fuel economy.

Table 1 - Performance of new-model year California vehicles versus applicable California standards

Program Year	Model Year	N	Average Mileage	% Meeting Applicable Standards
FY75	1976	34	8,700	71
FY75	1975	28	16,200	36
FY74	1975	35	8,100	37
FY74	1974	30	22,600	7
FY73	1974	10	11,300	40
FY73	1973	28	23,000	25

The results of this program are being used to:

1. Assess the effectiveness of the present light duty vehicle certification process with respect to the performance of defect-free, properly tuned, in-use vehicles, and

2. Provide background for possible further regulatory action such as limited adjustments on carburetors, ignition timing, and choke settings, and

3. Generate information for use in design of inspection and maintenance programs, selective enforcement audit and potential recall actions.

In the entire program, 400 vehicles were tested; 100 each in Detroit, Chicago, Washington, D.C., and San Francisco. Results from the 300 vehicles from Detroit, Chicago and Washington, D.C. were previously reported (Reference 4). This report concerns the remaining 100 vehicles from San Francisco.

The results of the final 100 vehicles in the program yield more information than would be expected from the completion of the program alone. The previous 300 vehicles were certified to meet 49-state emission standards for 1975-1976 model year passenger cars. The 100 San Francisco vehicles were certified to meet the stricter 1975-1976 California vehicle emission standards. The different emission control strategies required by slightly different standards yielded results different from those of the 49-state vehicles. These California results prove interesting as both a comparison with the 49-state as well as an examination of the in-use effectiveness of the California strategies. This last point may prove illuminating with regard to reliability and effectiveness expectations of various emission control systems, when stricter emission standards are required for the 49 states. Current California emission standards and control techniques may not be directly applied nationwide, but analysis of their effectiveness with respect to the current California standards may provide information enabling the EPA and the vehicle manufacturers to anticipate reliability or other problems prior to implementation of similar technology on a nationwide basis.

The vehicles included in this program were 1975 and 1976 model year vehicles. Each vehicle received the Federal Test Procedure, the Highway Fuel Economy Test, and five short cycle tests. The short test results are not included in this report but can be found in the contractor report on this project (Reference 5). This paper describes the design of the program and the results obtained from the 100 California vehicles.

Program Design

The basic program design for San Francisco vehicles, as for all others, called for a precise scenario of tests, inspections, maintenance actions and retests. The actual sequence was determined after an analysis of the inspection and emission test results.

100 vehicles were to be obtained in and around the San Francisco area for test by Automotive Environmental Systems, Inc., an independent testing laboratory under contract to EPA. The 100 vehicles consisted of approximately equal numbers of vehicles from each of the three major domestic automobile manufacturers. Within any manufacturer's sample, the actual vehicle make and model was specificed using a sales weighting technique. The vehicles were selected from the general public at random

with the requirements that all vehicles be 1975 or 1976 models which were less than 24 months old and have accumulated less than 27,000 miles. Owners were requested to fill out questionnaires to ensure that vehicles actually tested were as representative as possible. The questionnaire also yielded information regarding owner usage and maintenance of the vehicle.

The actual tests performed were the 1975 FTP, without the evaporative emission measurements and extensive preconditioning used in Certification, the HFET, and the short cycle tests as proposed by EPA (Vol 42 Federal Register, May 25, 1977, p. 26741). The short tests were performed to provide data to select test procedures for future I/M programs by state and local areas.

The test-maintenance series consists of tests alternating with inspection and maintenance actions on any vehicle "malperformance" (any emission-related component or system not operating properly for any reason). Subcategories of malperformance are maladjustments, disablements, and defects. Maladjustment refers to either willful or inadvertent adjustment of a parameter so that it is not within certain, defined tolerances. Disablements are either willful or inadvertent actions on non-adjustable components so as to render them inoperable, such as disconnecting or plugging vacuum hoses. Defects are those malperformances ascribed to either a fault in manufacturing or an unusually rapid deterioration of a component. More complete definitions of these terms are found in Appendix A.

The actual test sequence begins with an initial, as-received FTP, HFET, and Short Cycle sequence. A set of tests was performed after correction of any observed maladjustments and disablements. A third set, if necessary, was performed following replacement of failed emission components, combined with a major tune-up. Due to the suspected frequency of maladjusted idle mixture and its effect on FTP emission levels, correction of this parameter and idle speed were treated separately from other corrections of maladjustments and disablements. The resulting sequence, as described in detail in Appendix B, consisted of: an initial test in as-received condition; a second test following correction of all maladjustments and disablements except idle mixture and idle speed; a third test after idle mixture and idle speed are corrected; and a final test following a major tune-up during which defective components are repaired or replaced.

Seven of the 100 vehicles were retained and conducted through a "selective malperformance loop." These vehicles were each in a proper state of tune and were found to pass their most recent FTP. These seven vehicles were then used in a series of tests after certain maladjustment and disablement actions in order to determine their effects on exhaust emissions and fuel economy.

Conduct of the Program

The actual vehicle testing was performed at AESi's facilities in Westminster, California between March, 1977 and January, 1978. Test vehicles were trucked from the procurement site in San Francisco to the test site, and returned by truck upon completion of the test sequence. Prior to testing, the manufacturers were solicited for assistance in the program. General Motors Corporation, Ford Motor Company and Chrysler Corporation each provided technical assistance in the form of engineers and technicians to support the contractor's mechanics in the program. The manufacturers were allowed access to test results from their own vehicles. After the normal test sequence was completed, manufacturer's suggestions for further diagnostic, repair, or adjustment actions were solicited on failed vehicles.

Program Results

"As Received" Emission Levels - Results of the initial test on the 100 vehicles are displayed in Table 2 and Figure 1. Table 2 corroborates the previous observations that many relatively new, in-use vehicles cannot meet the emission standards corresponding to their model year. Despite the stricter California emission standards, a somewhat higher percentage of the test fleet passed these standards than passed the federal standards in the 300 vehicles tested in 49-state configuration. The initial test pass rate for this testing is between the pass rates for the two Emission Factors programs cited in Table 2. The fleet mix may contribute to this number, as these Restorative Maintenance vehicles were only from the three major domestic manufacturers, while Emission Factors vehicles included imports and smaller domestic manufacturers.

Table 2 - Comparison of Exhaust Emission Levels of California Vehicles between Emission Factors (EF) and Restorative Maintenance (RM) Programs

Model Year	Program	N	Average Mileage	HC (gm/mi)	CO (gm/mi)	NO_x (gm/mi)	% Meeting Standards
1975/1976	RM	100	14,781	.84	11.4	2.10	47
1976	EF	34	8,700	.72	7.95	1.57	71
1975	EF	35	8,100	.52	6.59	2.38	37.1

The emission values given in Table 2 are fleet averages for all 100 vehicles in their initial test. The fleet average HC meets California's 1975/1976 standards (.9 HC, 9.0 CO, 2.0 NOx) while the average CO and NOx do not. Conclusions based on this data alone are tenuous since several vehicles had very high emission levels, boosting the fleet average substantially. Figure 1 describes specific failure modes for

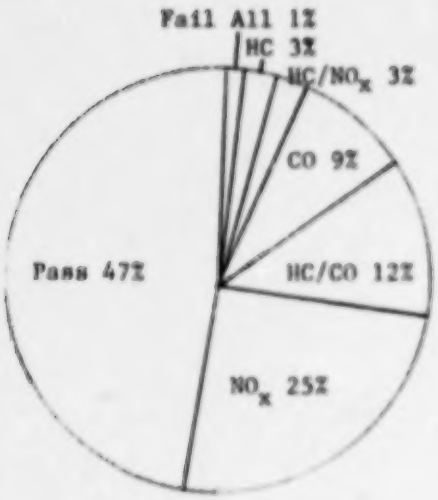


Figure 1-Pass/Fail outcomes on the initial test

the initial test. (HC/CO corresponds to failure in both HC and CO levels). Consideration of both Table 2 and Figure 1 leads to some qualitative idea of how much the failed vehicles missed their standards. The proviso regarding singular high emission vehicles precludes any precise statement, but the trend seems fairly clear - the majority of the fleet failed the first test, but not by a large margin, since the first test average values are close to the standards.

Underhood Inspection - The underhood inspection following the first test showed 63% of the vehicles had some system malperformance. The specific system breakdown is shown in Table 3. The data shows 4 major areas of malperformance. The most prevalent was the removal or breakage of the limiter caps over the carburetor idle mixture screws, which was found on 38% of the vehicles. On 29%, the ignition timing was found to differ from the manufacturer's specification by more than 2°. The 17% EGR malperformance reflects plugging of vacuum lines to the EGR or damage to the valve itself. The last major area of malperformance was choke and choke settings. Choke settings out of tolerance were found on 11% of the test vehicles. Overall, some manufacturer's vehicles demonstrated more frequent malperformance in a given area than others. The most apparent examples of this are the rate of limiter caps found missing or broken, maladjustment of timing, and EGR disablement. Chrysler limiter cap problems occurred in 58% of their vehicles, while Ford and GM had 36% and 21% respectively. Ignition timing changes were most frequent in Fords, at 48%, compared to 21% for Chrysler and 18% for GM. EGR valve disablements were found on 46% of the Chryslers, but no Fords and 6% of GM cars had this problem. These manufacturer variations may reflect a multitude of factors, from driveability problems to ease of adjustment (or maladjustment). Further examination of these characteristics in future EPA efforts may prove valuable in ascertaining the causes of certain types of system malperformance.

Table 3 - Percent of Emission Component Malperformance by System

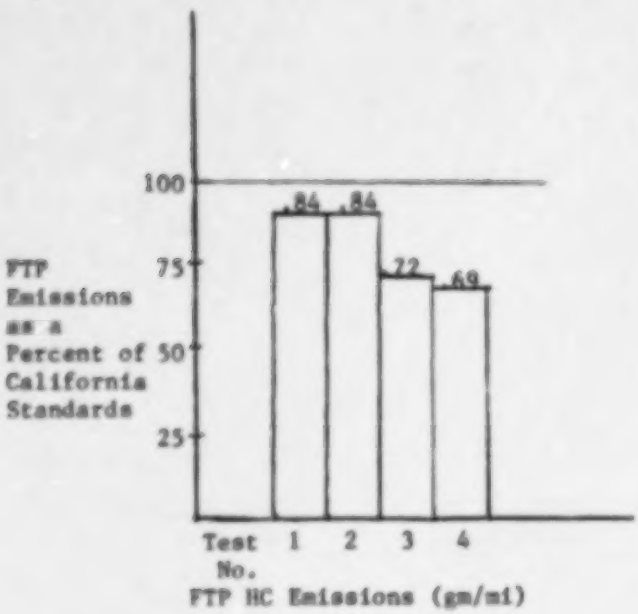
Emission System		Percent Malperformance
Induction		5
Fuel System		43
a) Limiter Caps	38	
b) Choke	11	
c) Other	1	
Ignition		29
a) Timing	29	
b) Other	0	
EGR		17
Air Pump		0
PCV		0
Exhaust		0
Other		0
Any System		63

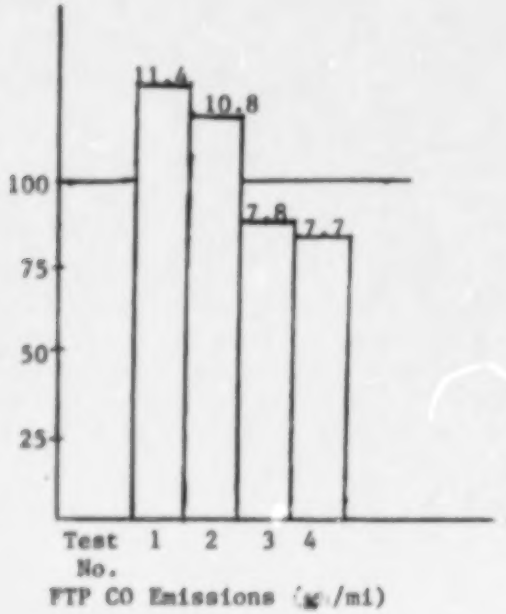
Table 4 shows calculations of the relative importance of maladjustments and disablements to passing or failing the FTP. (Percentages shown are based on the total vehicle fleet) This table demonstrates a not altogether unexpected result--up to a point, emission control technologies are fairly tolerant of what is here called maladjustment and disablement. This is reflected in the fact that for the vehicles that passed the FTP the first time, roughly half had maladjustments and disablements and half did not. For the vehicles that failed the FTP, a much larger number of vehicles had maladjustments and disablements - 38% - than did not - 15%. Thus, sixty six percent of the vehicles with maladjustment or disablements failed the initial FTP while 60% of the vehicles without maladjustments or disablements passed the FTP, indicating that the presence of maladjustments or disablements is a strong influence on the ability to meet the standards of a vehicle. Nevertheless, it is significant that 15% of the vehicles had no maladjustments or disablements, yet still failed the initial FTP.

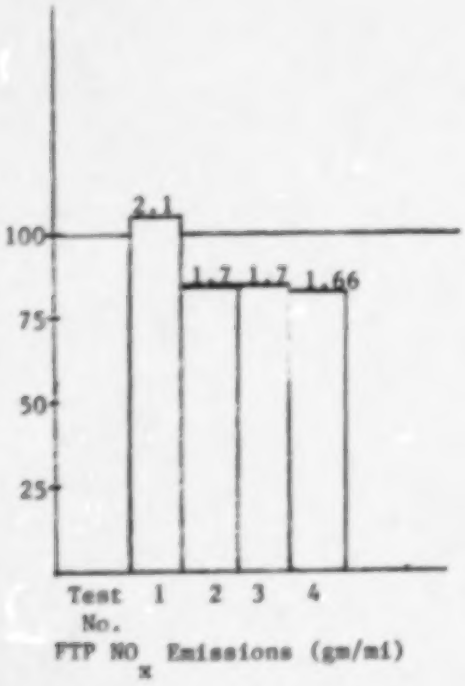
Table 4 - Performance of Vehicles on their Initial Test Results versus the Presence or Absence of Maladjustments or Disablements

	Met FTP Standards	Failed FTP Standards
With Maladjustments or Disablements	25%	38%
Without Maladjustments or Disablements	22%	15%

Emission Reductions After Maintenance - After completion of the inspection, those vehicles that passed Test 1 and were found to have no maladjustments or disablements were released to their owners. Those vehicles with maladjustments and disablements other than idle mixture and idle speed had them corrected at this point. Failure of Test 2 required correction of these idle speed and mixture and a Test 3. Following Test 3, any failing vehicles left in the loop were subjected to a major tune-up, complete with replacement of any defective parts. These vehicles then received Test 4. Figure 2 shows the average fleet emission results after each test. These results are calculated as total fleet averages following a given test, so all 100 cars are averaged at each test using either the results for that test, or the most recent previous test results if the current test was not performed. This figure and Figure 3 indicate the most successful maintenance actions occurred between test 2 and 3. Maintenance between tests 1 and 2 also proved effective. The tune-up and component replacement between tests 3 and 4 had somewhat less effect.







Test Number
1-as received test
2-after correction of maladjustments and disablements(except idle mixture and idle speed)
3-after adjustment of idle mixture and idle speed
4-after major tune-up and repair of repair of any defective components

Fig. 2-Fleet average emission levels after successive stages of maintenance

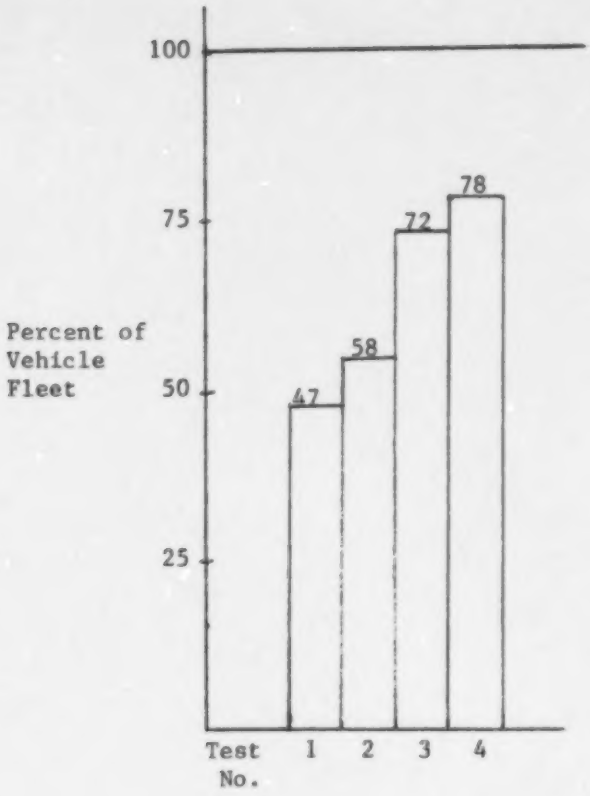


Fig. 3-Cumulative percentage of vehicles meeting standards after successive stages of maintenance

Ultimate Non-Compliance - As evidenced by Figure 3, 22% of the vehicles in the fleet were not able to pass the California emission standards. The final modes of failure for the vehicle fleet are shown in Figure 4. Final average emissions for these vehicles were, in the case of CO, significantly altered by one vehicle which had 22 times the standard in Test 4. Without this vehicle, the remaining 21 had average emissions of: 1.03 HC, 9.5 CO, 1.86 NOx. With the outlying vehicle, HC and NOx were essentially the same, and CO went to 18.0. Comparison with Table 2 reveals that even the vehicles that never passed, had improved CO and NOx average emissions (excluding the outlying vehicle) and slightly worse HC emissions. Except for the one vehicle, the spread of emission values for this group was relatively small, in contrast to the original test values. Thus, the maintenance actions performed in this project resulted in some significant emissions improvement, even for vehicles that never passed the California standards.

Fuel Economy - Miles-per-gallon figures were calculated for each vehicle during the FTP and HFET. The results of maintenance on the test fleet mileage was negligible. Shown in Table 5 and Figure 5 are these results compared to the FTP and HFET values as published in Gas Mileage Guide for New Car Buyers. No particular maintenance action strongly affected the fleet average fuel economy figures. These data corroborate those of the previous report in which no overall mileage advantage is gained by maladjustment or disablement of emission-related components. Similarly, little was gained by maintenance actions in terms of fuel economy values.

Table 5 - Average Measured Fuel Economy Results as a Percentage of Applicable Guide Values

	N	FTP	HFET
Initial	100	94%	93%
Final Test	100	93%	95%

Selective Malperformance

Those vehicles chosen for the selective malperformance loop received a series of maladjustments or disablements and subsequent tests in order to determine the effect of certain actions on emissions. In this test, seven vehicles were used to conduct this series. All seven were in proper operating order and met their emission standards prior to initiating the test sequence. The major individual actions taken as well as their emission results are displayed in Table 6.

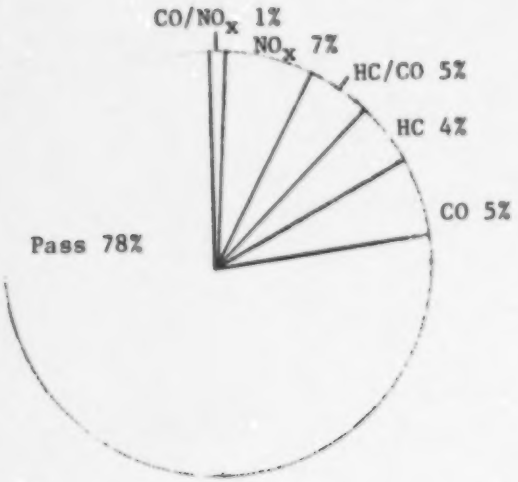


Fig. 4-Pass/Fail outcomes after the restorative maintenance was complete

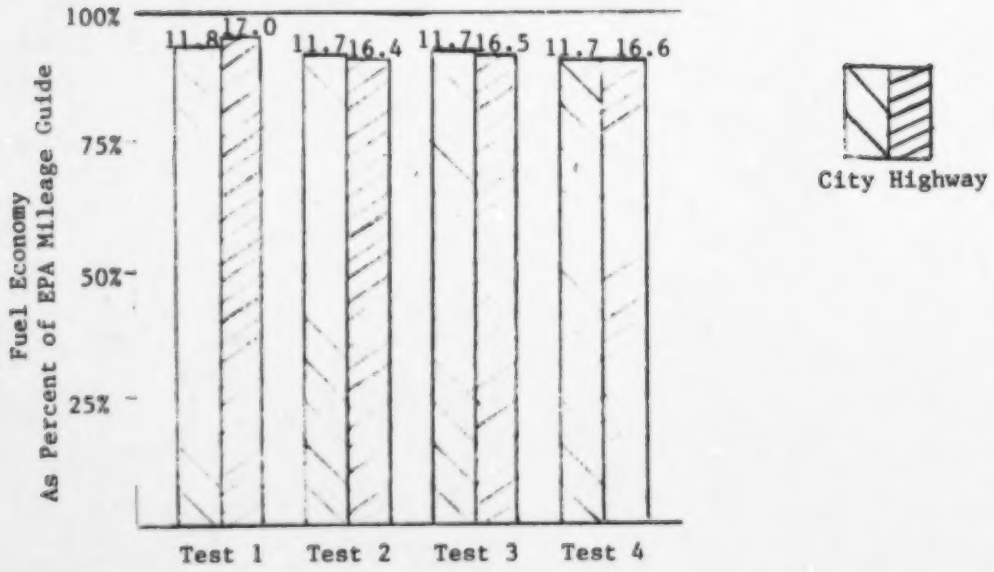


Fig. 5-Fuel economy as a percentage of EPA Mileage Guide figures, following each test

Table 6 - Percentage Emission and Fuel Economy Increases Resulting from Selective Maladjustments and Disablements

Action	N	FTP HC	FTP CO	FTP NO_x	FTP MPG	HFET
Plug EGR	7	-15%	10%	200%	5.0%	7.3%
Disconnect Air Pump	5	360	1200	-40	-2.3	.9
Full Manifold Vacuum to Distributor	4	41	42	48	2.2	.9
Lean Best Idle	6	10	32	3.7	-3.7	-3.7
Bypass Spark Delay	2	23	11	58	7	3
Disconnect Electric Choke Assist	2	69	200	-9	-5	-5

The most significant changes in emissions occurred when the air pump was disconnected. Inspections of the test vehicles had revealed no vehicles with this type of malperformance, however, Of more immediate interest are the results for the more commonly observed types of malperformance. Each of the seven vehicles had their EGR system plugged and measured a 200% average increase in NOx. A significant HC and CO increase was recorded when the vehicle was tuned to the classic "lean best idle" configuration. Other induced problems yield significant alteration in emissions, but were found to occur infrequently in the test fleet.

Conclusions

The primary conclusion reached as a result of this study is that disablements and maladjustments of in-use vehicles are common and have a significant effect on individual vehicle emissions, as well as overall contributions to air quality. This finding is identical to that from the corresponding effort on 49-state vehicles. Specific items which support this conclusion are listed below:

1. The majority of vehicles tested --53%-- were unable to meet the 1975-1976 California emission standards when tested in as-received condition.

2. A large proportion --63%-- had some form of maladjustment or disablement of engine or emission components. Most common examples were broken or missing limiter caps, maladjusted timing, and disablement of the EGR valve.

3. More than 70% of the vehicles that failed the first test exhibited some form of maladjustment or disablement.

4. The maintenance actions to correct maladjustments and disablements proved more successful than major tune-up and component repairs in allowing vehicles to pass succeeding tests.

5. Mileage measurements indicate that while certain specific actions may allow increased fuel economy, no appreciable advantage in fuel economy on a fleet average basis is gained by disabling or maladjusting emission components.

6. Specific emission effects due to selected maladjustments or disablements as evidenced by the selective malperformance loop, indicate the relative sensitivity of the emission values to various maladjustments or disablements on individual vehicles.

Although it is clear that a significant improvement in total vehicle emissions is attainable if vehicles can be kept free of maladjustments and disablements, care should be exercised in extending the precise results of this program outside of its bounds. All test were performed in a carefully controlled laboratory environment. Inspections and maintenance were performed by trained mechanics with assistance from representatives of the automobile manufacturers.

Although different in detail, the results of the San Francisco Restorative Maintenance testing are basically similar in substance from the Detroit, Chicago, and Washington, D.C. results. Their basic agreement lends similar conclusions to all the sites. The added point of interest in the San Francisco tests was that despite different standards in California, emission performance of California vehicles with respect to California standards was similar to the emission performance of 49-state vehicles with respect to 49-state standards throughout the range of maladjustments and disablements encountered.

References:

1. J.A. Rutherford, "Automobile Exhaust Emission Surveillance - Analysis of the FY1975 Program." EPA Report No. EPA 460/3-77-022, December 1977.

2. A.P. Berens and Michael Hill, "Automobile Exhaust Emission Surveillance Analysis of the FY1974 Program" - EPA Report No. EPA 460/3-76-019, September 1976.

3. M.Van Loan and J.R. Sachtschale, "A Study of Emissions from 1967-1974 Light Duty Vehicles in Los Angeles and St. Louis," EPA Report EPA 460/3-74-016, October, 1974.

4. J.T. White III, "An Evaluation of Restorative Maintenance on Exhaust Emissions from In-use Automobiles," SAE Paper No. 780082.

5. Automotive Environmental Systems, Inc., "Evaluation of Restorative Maintenance on 1975 and 1976 Light-Duty Vehicles in San Francisco, California."

APPENDIX A

RESTORATIVE MAINTENANCE EVALUATION
Explanation of Performance Codes

The performance codes used for components and systems in this program were determined in accordance with the following reasoning:

No Malperformance: The component or system was present, inspected, and found to be operating properly. This code was also used in cases where the component or system was not able to be inspected, but where we had no evidence that it was not operating properly. An example of this is mechanical valve adjustment on a vehicle which passed early in the sequence and was released without an actual inspection. Comments following this rating could provide further information on the component such as whether it was replaced as part of a major tune-up or if it exhibited some characteristic which may lead to premature failure.

Maladjusted: This refers to an adjustable component or system which was found to be outside of the tolerance band around the nominal specification. Examples are idle speed, basic timing, and choke settings. Acceptable ranges for the idle speed were $\pm$ 100 rpm while $\pm$ 2° was used for basic timing. Allowable ranges for choke adjustments were the production tolerances as provided by the manufacturer's representative.

Solely for the purpose of coding and analysis in this program, as-received idle mixture adjustment was judged on the basis of a 0.5% tailpipe idle CO cutpoint. This treatment had no impact on the actual vehicle testing which was performed according to manufacturers' specifications but is useful in making comparisons among the various vehicles and in the evaluation of a basic idle mode short test.

Disabled: A component or system which is found not to be functioning properly due to some person's willful or inadvertent action. Examples are plugged, disconnected, or rerouted vacuum lines, carefully damaged EGR valves and broken or missing limiter caps.

Defective: A component which is found not to be functioning properly due to a manufacturing fault or normal deterioration prior to any service interval. Examples of these are leaking vacuum diaphragms, coolant temperature sensing vacuum switches which do not open or close at appropriate temperatures, timing devices which stay on or off too long or too short, and broken EGR backpressure transducers.

This code is also used when the condition of the component or system cannot be absolutely determined by the basic functional checks prescribed in the program but a replacement and a subsequent emission test reveals a significant difference in emission levels. This was the case where carburetor replacements corrected a high CO problem.

APPENDIX B

RESTORATIVE MAINTENANCE EVALUATION

(See flow chart for sequence)

LOCATE CANDIDATE VEHICLES - Potential test vehicles will be drawn from the general public using commercially-available mailing lists or other means designed to ensure overall randomness of the sample.

SCREEN - Willing owners whose vehicles appear to meet the vehicle configuration criteria will be contacted to verify the information provided and to obtain any missing items. At this time, the owner will be questioned with regard to vehicle age and mileage, types of usage, and extent of possible driveline modifications. He will be asked to allow a tune-up or minor adjustments to be performed, if necessary, and informed of the incentive package and possible test duration. The owner should also be informed that his vehicle will be returned to him tuned to manufacturer's specifications, in a condition that allows it to pass its emission standards, or both. If the owner remains willing and the vehicle still appears to be an acceptable candidate, the vehicle will be scheduled for testing.

Upon arrival at the laboratory, the candidate vehicle will be given a cursory examination to determine its suitability for the program. The results of this may be noted although no corrective actions are to be taken at this time. Normally, the complete inspection will be performed in conjunction with the Emission Control Component Function Check following the initial test sequence. Also during this screening process, a sample of tank fuel will be drawn and tested for lead content and the owner will be interviewed to complete the questionnaire.

The outcome of this portion of the sequence will be to accept or reject the vehicle for testing. A modest amount of maladjustment and disablement on some vehicles is expected. However, vehicles which have undergone modifications of any kind which are not readily, inexpensively or ultimately restorable will be rejected from the sample at this point. Normally, the contractor will make the determination although more complex decisions may be made jointly by representatives of the contractor, manufacturer and EPA. While a failing mark in a number of areas would not disqualify a candidate vehicle, immediate rejection will result from excessive age or mileage, extensive modifications, evidence of improper use, or indications that a catalyst-equipped vehicle has used leaded fuel. If accepted, the owner will complete the remaining loan vehicle and test agreement forms and his vehicle will be retained for the program.

DRAIN FUEL, COLLECT SAMPLES - Once accepted into the program, the fuel in each vehicle will be drained, with two samples taken. One of the samples will be made available to the manufacturer while the other will be shipped to a laboratory designated by the EPA Project Officer.

TEST - The actual test sequence on each vehicle begins with the addition of test fuel to 40% of tank fuel volume, rounded to the nearest gallon. The vehicle shall then be driven for at least ten minutes on city streets to ensure the test fuel has fully purged the system. During this time, a driveability evaluation of the vehicle in a warmed-up condition will be conducted. Cold-start operation will be evaluated and recorded during the subsequent FTP driving cycle.

The dynamometer test sequence begins after the prescribed soak period. Tests to be performed are the 1975 FTP (but without fuel tank heat build or evaporative emission measurements), the Highway Fuel Economy Test (HFET) and the five short cycles. Appropriate dynamometer settings and vehicle starting procedures will be provided by the manufacturer's representative. All test settings and vehicle specifications are to be "as-certified". No field fixes or running changes may be added without prior approval of the EPA Project Officer.

Immediately after the dynamometer sequence, basic engine parameters shall be measured and recorded. Emission test results should also be calculated to permit a timely review of the test and to expedite routing of the test vehicle through the program.

PERFORM INSPECTION FOR MALADJUSTMENT AND DISABLEMENT - This procedure may be conducted in conjunction with the functional checks of the emission control components. For the purpose of this examination, the pass-fail decision for each system will be based on whether it has experienced maladjustment or disablement. Areas that are deficient due to deterioration or production defects are disregarded here but will be treated as failures during the functional checks of the emission control components.

ANY DISCOVERED - This block requires a decision based on review of the Maladjustment and Disablement Inspection Form. Failures discovered in areas other than limiter caps, idle speed and idle mixture will cause a "yes" answer, correction and another test sequence.

CORRECT - Maladjusted or disabled items, except those described above, will be corrected. While idle speed and mixture which are out of specifications are also considered maladjustment, their correction will be treated separately.

INSPECT EMISSION COMPONENTS - Each vehicle in the program will undergo a functional check of each of the emission control devices and other emission-related components. Precise procedures and specifications for these inspections are found in the shop manuals. At this time, the individual devices and systems are only to be inspected with the conditions recorded. Any corrective actions required will normally be performed later in addition to the major tune-up.

FTP RESULTS - This decision will be based on the outcome of the preceding test sequence with regard to 1975/1976 California Standards.

RECORD IDLE SPEED AND CO - Vehicles which pass test #1 or #2 will be returned to their owners. Before the vehicle is released, the idle speed and idle mixture will be measured and recorded.

INSPECT IDLE SETTINGS - Chrysler and Ford vehicles which reach this point will be inspected for idle speed and idle mixture using the procedures specified by the manufacturer. Because the nature of General Motor's procedure for idle mixture adjustment precludes inspection, these vehicles will proceed directly to the "Adjust" block.

WITHIN SPECIFICATIONS - Chrysler and Ford vehicles may be found to be within tolerances for both parameters. Such vehicles will not be adjusted but will immediately receive the required scheduled maintenance and repair of defective emission control devices.

ADJUST - General Motors vehicles and ones of the other manufacturers which are found to be out of specifications will receive the appropriate adjustments. Malfunctioning emission control devices which would prevent proper settings (e.g. idle stop solenoid), may also be corrected at this time. Following this procedure, the vehicle shall be given another test sequence with FTP results again determining its disposition in the program.

MAJOR TUNE-UP AND EMISSION COMPONENT REPAIR - Vehicles which arrive at this block will undergo correction of defective emission control devices and other emission-related components. The major tune-up shall be performed as prescribed in the appropriate shop manual. The manufacturer's representative may provide assistance and guidance in the performance of these tasks. All replacements shall be made with OEM parts. A number of local auto dealers are to be contacted in an attempt to obtain proper replacements for emission components. In some cases, the manufacturer's representative may actually provide some emission-related parts which are difficult to obtain from local sources. This will not, however, reduce the requirement for contact with local dealers.

SEEK COUNSEL OF EPA AND MANUFACTURER - Vehicles which are unable to pass the FTP after a major tune-up and correction of all malfunctioning emission control devices will arrive at this block. A substantial number of these should be very close to the standards and no further action will be warranted. However, in some cases, the manufacturer's representative may choose to examine the vehicle and its test results more closely to determine a possible explanation. This could result in previously undiscovered maladjustments or disablements or in an extraordinary problem with the vehicle itself. He may also wish to perform some additional adjustments on the vehicle or perform an applicable field fix or running change. These cases are to be handled between the manufacturer and EPA and there may be instances in which the vehicle will receive another test.

ONE OF CHOSEN 5 - Although each vehicle which passes test #4 will be subject to further maladjustment, disablement and retesting, as many as five vehicles from each manufacturer will be chosen to pass through the "Selective Maladjustment" loop. The contractor shall notify the EPA Project Officer as each vehicle reaches this portion of the program. The Project Officer will then determine whether the vehicle is one of the chosen five.

SELECTIVE MALPERFORMANCE - This will represent what is considered to be a prevalent form of modification to the make/engine family under test. It will consist of some combination of engine parameter readjustments as well as alteration of vacuum, mechanical or electrical signals. The settings and other actions to be performed will be determine by the EPA Project Officer after the vehicle has been selected for this phase of the project.

RESTORE TO SPECIFICATIONS - This block provides for restoration of the vehicle's engine and emission control system to manufacturer's specifications prior to further testing or return to its owner. Since

vehicles which have arrived at this later stage of the program have received extensive inspection and maintenance earlier, this action is simply the reversal of the "Selective Malperformance" or "Readjustment" actions.

ADJUST ONE PARAMETER - The purpose of this loop is to quantify the effect of individual parameter readjustments on exhaust emissions and fuel economy. At this point, one or more of the basic parameters such as idle RPM, idle mixture or ignition timing will be changed, holding the others constant. Alteration of vacuum, electrical, or mechanical signals may also be involved. The EPA Project Officer will provide the precise settings for each vehicle after it has been accepted into this portion of the program. After this adjustment, the vehicle will receive another test sequence.

SEQUENCE COMPLETE - This decision is based on the number of tests remaining in the contracted effort but will also be based on the current needs for information on certain vehicles and in various areas of readjustments. Normally, each vehicle will cycle through the loop four times. The EPA Project Officer will determine the length of the sequence on an individual basis for each vehicle. Once the sequence is completed, the vehicle will be readjusted to manufacturer's specifications.

RETURN VEHICLE TO OWNER - The contractor will prepare the vehicle for return to its owner as well as fulfill the provisions of the incentive package.

TESTING COMPLETE - Once the prescribed number and types of vehicles have been procured and successfully tested, the testing portion of the project is complete.

PREPARE FINAL REPORT - The data gathered by the contractor are to be assembled into a final report using a format supplied by the EPA Project Officer. This report will include a narrative description of the project, summary tables and individual test results on each vehicle.

Reproduced from best available copy.